CLAIMS

We claim:

1. An annular reactor assembly for exchanging heat between at least two separate fluid streams flowing therethrough, the reactor comprising:

an inner cylinder forming an inner area;

an outer cylinder surrounding the inner outer cylinder and forming an annular area therebetween;

fins which extend at least partially into at least one of the: inner area and the annular area and which are oriented in an essentially longitudinal direction along a circumference of at least one of: the inner tube and the outer tube; and

control means for selectively controlling heat transfer between a first fluid passing through the inner area and a second fluid passing through the annular area, the control means being connected to a terminal end of at least one of: the inner cylinder and the outer cylinder.

2. An annular reactor according to claim 1, wherein the control means comprises a variable cover.

3. An annular reactor according to claim 2, wherein the variable cover comprises plurality of overlapping plates fixed to a central pivot.

4. An annular reactor according to claim 2, wherein the variable cover comprises an expanding fan fixed to a central pivot.

5. An annular reactor according to claim 1, wherein the control means includes an automated system for monitoring at least one of: the first fluid and the second fluid, and for responsively altering the heat transfer between the first fluid and the second fluid in order to achieve a desired operating state.

6. An annular reactor according to claim 1, further comprising a central core structure located within the inner area.

7. An annular reactor according to claim 6, wherein the fins are oriented in an essentially longitudinal direction along a circumference of the central core structure.

8. An annular reactor according to claim 6, wherein the central core structure includes a hollow portion capable of housing other components.

9. An annular reactor according to claim 1, wherein the fins are arranged in a pattern including at least one of: straight, rectangular offset strip, offset strip, perforated, triangular, louvered, and wavy.

10. An anular reactor according to claim 9, wherein the fins are constructed to optimize at least one of: the heat transfer between the first fluid and the second fluid, a flow pattern of the first fluid or the second fluid within the respective inner area or the annular area, and to provide structural support between the inner cylinder and the outer cylinder.

11. An annular reactor according to claim 6, wherein the fins are arranged in a pattern incuding at least one of: straight, rectangular offset strip, offset strip, perforated, triangular, louvered, and wavy.

12. An annular reactor according to claim 11, wherein the fins are constructed to optimize at least one of: the heat transfer between the first fluid and the second fluid, a flow pattern of the first fluid or the second fluid within the respective inner area or the annular area, and to provide structural support between at least two of: the central core structure, the inner cylinder, and the outer cylinder.

13. An annular reactor according to claim 1, further comprising catalyst means for catalyzing a reaction to convert the first fluid into a desired end product.

14. An annular reactor according to claim 13, wherein the catalyst means is deposited on at least one of: the fins, the inner cylinder, and the outer cylinder.

15. An annular reactor according to claim 14, wherein the fins are arranged in a pattern incuding at least one of: straight, rectangular offset strip, offset strip, perforated, triangular, louvered, and wavy.

16. An annular reactor according to claim 15, wherein the fins are constructed to optimize at least one of: the heat transfer between the first fluid and the second fluid, a flow pattern of the first fluid or the second fluid within the respective inner area or the annular area, and to provide structural support between the inner cylinder and the outer cylinder.

17. An annular reactor according to claim 6, further comprising catalyst means for catalyzing a reaction to convert the first fluid into a desired end product.

18. An annular reactor according to claim 17, wherein the catalyst means is deposited on at least one of: the fins, the inner cylinder, the outer cylinder, and the central core structure.

19. An annular reactor according to claim 18, wherein the fins are arranged in a pattern incuding at least one of: straight, rectangular offset strip, offset strip, perforated, triangular, louvered, and wavy.

20. An annular reactor according to claim 19, wherein the fins are constructed to optimize at least one of: the heat transfer between the first fluid and the second fluid, a flow pattern of the first fluid or the second fluid within the respective inner area or the annular area, and to provide structural support between at least two of: the central core structure, the inner cylinder, and the outer cylinder.

21. An annular reactor assembly according to claim 13, wherein the catalyst means is in fluidic contact with the inner area and the annular area; wherein the catalyst means generates combustion reactions and hydrogen-reforming reactions; and wherein the

combustion reactions occur in either the inner area or the annular area and the hyrdrogen-reforming reactions occurs wherever combustion reactions are not occurring.

22. An annular reactor according to claim 21, wherein there are two separate catalyst materials, the first catalyst material being specifically formulated to generate combustion reactions and the second catalyst material being specifically formulated to generate hydrogen-reforming reactions.

23. A method of constructing an annular reactor assembly comprising the steps of:

forming an inner cylinder having an inner space;

forming an outer cylinder;

forming a plurality of circumferential fins extending longitudinally along at least one of: an interior surface of the inner cylinder, an exterior surface of the inner cylinder and an interior surface of the outer cylinder;

subsequent to all of the forming steps above, concentrically arranging the inner cylinder and the outer cylinder to create an annular area between the inner cylinder and the outer cylinder;

subsequent to the arranging step above, providing manifolding and flow control devices to permit a first fluid to selectively flow through the inner space and a second fluid to selectively flow through the annular space; and

as a final step, sealing the assembly to prevent unwanted loss of the first fluid or the second fluid and to further prevent mixing of the first fluid and the second fluid.

24. A method of constructing an annular reactor according to claim 23, wherein the fins extend at least partially into the inner space and the annular space and wherein forming at least one of: the inner cylinder, the outer cylinder, the fins on the interior surface of the inner cylinder, the fins on the exterior surface of the inner cylinder and the fins on the interior surface of the outer cylinder, is accomplished using an extrudable material.

25. A method of constructing an annular reactor according to claim 23, wherein forming at least one of: the inner cylinder, the outer cylinder, the fins on the interior surface of the inner cylinder, the fins on the exterior surface of the inner cylinder and the fins on the interior surface of the outer cylinder, is accomplished using an EDM process and wherein the EDM process initially starts with a solid block of metal.

26. A method of constructing an annular reactor according to claim 23, wherein the fins extend at least partially into the inner space and the annular space and wherein forming at least one of: the fins on the interior surface of the inner cylinder, the fins on the exterior surface of the inner cylinder and the fins on the interior surface of the outer cylinder, is accomplished by attaching at least one finned strip to a circumference of the inner cylinder and/or outer cylinder.

27. A method of forming an annular reactor according to claim 26, wherein the subsequently attaching at least one finned strip includes a brazing process.

28. A method of constructing an annular reactor according to claim 26, wherein the finned strip has a pattern including at least one of: straight, rectangular offset strip, offset strip, perforated, triangular, louvered, and wavy.

30. A method of constructing an annular reactor according to claim 24, further comprising the step of, prior to concentrically arranging the inner cylinder and the outer cylinder, coating at least a portion of at least one of the: the inner cylinder, the fins of the inner cylinder, the outer cylinder, and the fins of the outer cylinder, with a catalyst material which induces a reaction to convert at least one of: the first fluid and the second fluid, into a desired end product..

31. A method of constructing an annular reactor according to claim 30, wherein the catalyst material is specifically selected to induce at least one of: a combustion reaction and a hydrogen-reforming reaction.

32. A method of constructing an annular reactor according to claim 25, further comprising the step of, prior to concentrically arranging the inner cylinder and the outer cylinder, coating at least a portion of at least one of the: the inner cylinder, the fins of the inner cylinder, the outer cylinder, and the fins of the outer cylinder, with a catalyst material which induces a reaction to convert at least one of: the first fluid and the second fluid, into a desired end product.

33. A method of constructing an annular reactor according to claim 32, wherein the catalyst material is specifically selected to induce at least one of: a combustion reaction and a hydrogen-reforming reaction.

34. A method of constructing an annular reactor according to claim 26, further comprising the step of, prior to concentrically arranging the inner cylinder and the outer cylinder, coating at least a portion of at least one of the: the inner cylinder, the fins of the inner cylinder, the outer cylinder, and the fins of the outer cylinder, with a catalyst material which induces a reaction to convert at least one of: the first fluid and the second fluid, into a desired end product.

35. A method of constructing an annular reactor according to claim 34, wherein the catalyst material is specifically selected to induce at least one of: a combustion reaction and a hydrogen-reforming reaction.

36. An in-line, annular reactor system, including heat transfer reactions and other reactions, comprising:

control means for selectively controlling heat transfer between a first fluid and a second fluid passing through the reactor system;

an upstream annular module having an inner outlet for providing a first fluid and an annular outlet for providing a second fluid; the upstream module being specifically designed to perform a specific pre-heat transfer reaction upon at least one of: the first fluid and the second fluid;

a downstream annular module having an inner inlet for receiving the first fluid and/or a derivative of the first fluid and an annular inlet for receiving the second fluid and/or a derivative of the second fluid; the downstream module being specifically designed to perform a specific post-heat transfer reaction upon at least one of: the first fluid, the derivative of the first fluid, the second fluid, and the derivative of the second fluid; and

a heat transfer module having: an inner cylinder which encloses an inner area, the inner area being in fluidic connection with the inner outlet of the upstream module and the inner inlet of the downstream module; an outer cylinder which encloses the inner cylinder and forms an annular area between the inner cylinder and the outer cylinder, the annular area being in fluidic connection with the outer outlet of the upstream module and the outer inlet of the downstream module; and a plurality of fins positioned in a substantially longitudinal direction along a circumference of at least one of: the inner area of the inner cylinder and the annular area of the inner cylinder and the outer cylinder; the heat transfer module being specifically designed for transferring heat between the first fluid and the second fluid.

37. The in-line, annular reactor system of claim 36, wherein the inner area and the annular area of the heat transfer module each contain catalyst means for, concurrent with the heat transfer, converting at least one of: the first fluid and the second fluid, into a desired derivative thereof.

38. The in-line, annular reactor system of claim 37, wherein the catalyst means is specifically designed to perform hydrogen reforming; wherein the derivative of the first fluid and/or the derivative of the second fluid includes hydrogen-rich gas; and wherein the pre-heat transfer reaction and the post-heat transfer reaction both include reactions commonly required by a fuel processing system.

39. The in-line, annular reactor system of claim 38, wherein the reactions commonly required by a fuel processing system include at least one of: desulfurization, pre-reforming heat transfer, post-reforming heat transfer, selective oxidation, partial oxidation, and water-gas shift reactions.

40. The in-line, annular reactor system of claim 36, wherein the fins are arranged in a pattern which includes at least one of: straight, rectangular offset strip, offset strip, perforated, triangular, louvered, and wavy.

41. An annular reactor according to claim 40, wherein the fins are constructed to optimize at least one of: the heat transfer between the first fluid and the second fluid, a flow pattern of the first fluid or the second fluid within the respective inner area or the annular area, and to provide structural support between at least two of: the central core structure, the inner cylinder, and the outer cylinder.

42. The in-line, annular reactor system of claim 36, wherein the control means comprises a variable cover.

43. An annular reactor according to claim 42, wherein the variable cover comprises plurality of of overlapping plates fixed to a central pivot.

44. An annular reactor according to claim 42, wherein the variable cover comprises an expanding fan fixed to a central pivot.

45. An annular reactor according to claim 36, wherein the control means includes an automated system for monitoring at least one of: the first fluid and the second fluid, and for responsively altering the heat transfer between the first fluid and the second fluid in order to achieve a desired operating state.